

# STATUS OF TRADITIONAL FOOD PRESERVATION METHODS FOR SELECTED GHANAIAN FOODS

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## ABSTRACT

The effect of processing on nutrient quality becomes paramount in countries as Ghana where nutrient deficiency diseases are prevalent. Several foods (heating, trigger, tilapia, and cassava) were assayed for several nutrients before and after processing. In most instances proximate nutrients and some vitamins and minerals increased due to loss of moisture. Consumption of the dried product increases total nutrient intake for pregnant women and children who are nutritionally at risk.

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## INTRODUCTION

Ghana may be divided into three main climatic zones comprising the coastal savanna, the forest zone, and the northern high savanna zone. In addition to stock raising and farming, the major occupation in the coastal savanna is fishing. Food crops produced include cassava, maize, and vegetables. Both marine and inland river fishing are practiced. In the forest zone, the main occupation is the cultivation of cash crops like cocoa and timber. Major food crops include roots and tubers (mainly cassava, yam, cocoyam, and sweet potatoes), fruits, and vegetables and maize. Agriculture in the northern savanna area is confined to the rearing of livestock and cultivation of grains and root and tuber crops (4). Production of highly perishable and semiperishable commodities is therefore confined mainly to the coastal savanna and, to some extent, the forest zones. These are also the areas where traditional food preservation is widely practiced.

Local merchants and facilities, and prevailing environmental conditions are used in the treatment of foods to retard their rate of deterioration in traditional food preservation methods in Ghana. These techniques, as is the case in all traditional practices, were developed perhaps by chance or human ingenuity and passed on to the present day through successive generations. Slight variations in techniques, aimed at maximizing efficiency, might have occurred with time but the basic principles involved in traditional food preservation remain the same.

Four main reasons contribute to the need for effective food preservation in Ghana. These are the seasonality of food, perishability, marketing, and distribution. Most staple foods are highly seasonal and must be preserved from one growing season to another since the demand for these foods is perennial. In general, Ghana experiences two rainy seasons a year, the principal one reaching its maximum in May and June and the subsidiary one in October. These are the only times in the year for food crop cultivation in most parts of the country. Although fishing can be done throughout the year, the major season is from July to September when good species are caught in large quantities. It appears that the bulk of the country's food supply is produced during the period June-October each year. There is, therefore, the need for preservation to avoid waste and to ensure an off-season supply.

With the exception of the relatively shelf-stable crops such as the cereal and legume grains, the bulk of Ghana's food sources fall within the categories of highly perishable and semiperishable commodities described by Karel et al. (15). As noted by Rawnsley (26), the warm and moist climatic conditions contribute to the deterioration of food due to insects, fungi, and bacteria. Considerable degrees of postharvest food losses are therefore experienced each year in cases where effective preservation techniques are not available.

Traditional food preservation methods, in Ghana, are also aimed at preventing deterioration to facilitate effective distribution to areas where the particular commodity is not produced. Food traders also need preserved foods for storage against

anticipated high market prices. Most regions in Ghana practice some sort of traditional food preservation depending on the types of food commodities produced in the region by virtue of its geographic location or the climatic and soil conditions.

Traditional preservation techniques may have a two-way effect on the nutritional quality of the product. The beneficial effects in improving nutritional quality have been summarized by Hudson (11) as increasing palatability and digestibility, and destroying or minimizing the effects of toxic factors, hence making more nutrients available. On the other hand, some traditional processes in food preservation may also destroy or remove some essential nutrients or decrease their digestibility (28). Ghanaian traditional food preservation techniques may exhibit these effects in the quality of the preserved products.

### TRADITIONALLY PRESERVED FOODS

Food commodities that are traditionally preserved in one form or another include the root crops, some vegetables, and animal tissues. Preservation of these commodities may be done in one of two ways. Where possible the raw food is preserved to retain its freshness for future use in its original form, or it may be processed into products having different functional characteristics. The processed products have clearly defined observable changes in the composition or general properties of the food. They usually have longer storage life under natural environmental conditions.

Major root crops available in Ghana are cassava, yam, cocoyam, and sweet potatoes. The most perishable of these root crops is cassava, which is very widely cultivated especially in the southern parts of the country, and which, according to Ingram (12), accounts for more than half the total starch staple produced. Traditional techniques for root crop preservation have therefore been developed mainly for cassava.

Cassava roots (*Manihot esculenta*) start to deteriorate 1-7 days after harvest, the initial physiological deterioration being compounded by microbial action (10). Traditionally cassava is preserved for short periods in fresh form, or it may be processed into dry products which can be stored for several months.

Fruits and some vegetables are among those foods not traditionally preserved by Ghanaian villagers. Because of the wide variety of items, when one fruit or vegetable is unavailable, another of comparable nutritive value is available. Based on this premise, the need to preserve these foods has not evolved over the years as it has with other perishable food items. In addition, because Ghanaians are accustomed to the texture, appearance, and taste of fresh fruits and vegetables, any change from this form is not desirable or not readily acceptable. Mangoes, papaya, oranges, grapefruit, bananas, pineapples, avocado pears, baobab, guava, lemon, lime, and watermelon are examples of fruits available during one season or the other in the year.

Traditional ingenuity in food preservation is manifested more in fish preservation than any other food commodity in Ghana. Fish, an extremely perishable commodity, forms the major source of animal protein for a greater part of the Ghanaian population. Heavy losses are incurred during the periods of glut (July-September) if the bulk is not preserved soon after the catch is landed.

Traditional methods of preservation include smoking, drying, salting, and fermentation, or a combination of these methods may be applied. Other short-term preservation methods used are deep-fat frying and steaming with salt. These latter techniques are normally considered more of a method of food preparation than preservation. Techniques used in traditional fish preservation have been studied extensively and improvements have been suggested by various workers (13, 14, 18-22).

Livestock raising for household use is practiced in every part of the country and the need for meat preservation as a commercial venture is not as common as is the case in traditional fish preservation. Where necessary salting and smoking are used for home preservation or for the preservation of game intended for sale.

## **TRADITIONAL TECHNIQUES OF FOOD PRESERVATION**

In general, traditional food-processing and preservation techniques are based on principles similar to those used in modern industrial food processing and preservation. Unit operations such as crushing, pressing, filtration, floatation, sifting, and size classification are common in most traditional processes. Sophistication of equipment and efficiency of operation are the major things that distinguish the modern industrial process from the Ghanaian traditional one. Similar to what is obtained in modern food preservation (15), traditional food preservation in Ghana can be accomplished by chemical, biological, or physical means. Chemical preservatives used in traditional food preservation are mainly salt, sugar, and smoke. Alcoholic and acidic fermentations are the biological methods of preservation, while drying, concentration, and heating constitute the physical means of preserving most foods in Ghana. The choice of technique depends on the type of material to be preserved, available facilities, and the desired characteristics of the final product.

### **Preservation of Roots and Tubers**

Fresh cassava preservation is achieved by hot water treatment and by underground storage. Either of these short-term preservation techniques is used when it is desirable to retain the original functional and sensory characteristics of fresh

cassava. Hot water treatment involves the immersion of cassava in hot water at about 90°C for 3 to 5 min. This treatment may prolong the storage life for approximately 2 weeks (3). In underground storage, the cassava roots are buried in moist soil. The soil moisture content is maintained at a level that is not high enough to accelerate rotting and not low enough to cause dehydration. With proper care, this traditional technique can also keep the cassava fresh for about 2 weeks.

The problems associated with the storage of fresh cassava roots make it necessary to process them into a suitable product with low moisture content that can be more readily stored. The most important of the traditional forms of preservation are "gari" and "kokonte."

Gari, the most common preserved cassava product in Ghana, is prepared by roasting grated and fermented cassava in large pans over open fires. In this process, peeled and washed cassava roots are grated either by hand (over a perforated tin surface) or in a mechanically driven grater. The grated pulp is then packed in jute bags, which are closed by tying the mouth. The bags are then packed on wooden racks and heavy stones are placed on them to press out the starchy juice while fermentation proceeds for 3-4 days. The fermented pulp is further dried in the sun for a couple of days and roasted in open cast iron pans. Continuous stirring is ensured while roasting to keep the grains separate and to achieve uniform cooking. Partial gelatinization occurs. The product is sieved to produce a particle size of 10-100 mesh (1). The sour taste of gari, acquired during the fermentation stage, is preferred by Ghanaians and Nigerians. However, for people in Sierra Leone a sweeter taste is desired; therefore, during the fermentation stage several short periods of dewatering are carried out (30).

Kotonte is prepared by cutting peeled cassava roots into slices and sun-drying the pieces. The drying may be slow or fast depending on the weather conditions. Fermentation usually takes place and a relatively sour product results. This is the form in which yam (*Disocorea rotundata*) can also be processed for preservation (6). However, yams are not usually processed in Ghana. The products may be stored in bags as dried pieces or milled and stored in a powder form.

### Preservation of Fruits and Vegetables

Traditional methods for fruits and vegetable preservation are not common in Ghana. Where necessary, as in the case of pepper and okra, drying is used. Hot peppers harvested fully ripe are first blanched in boiling water for a few minutes, and dried on mats in the sun or in traditional ovens used for bread baking. Sun-drying is completed in about 2 days depending on the weather conditions. The product is stored whole or ground into powder for sale during the lean season. Okra is preserved in an essentially similar manner.

## Preservation of Fish

By far, sun-drying is the cheapest and simplest of the methods used (22) in Ghana for preserving fish. However, this is mostly used in combination with salting and/or fermentation for effective preservation of the product.

Ten to fifteen percent of fish landed in Ghana are preserved by straight sun-drying. Anchovies, sardines, trigger, tilapia, and moonfish are examples of fish that are sun-dried. Usually the fish are washed and spread on the ground (beach sand or fine gravel) or on mats and allowed to dry for 3-5 days (20).

Herring, seabream, and mackerel are the most popular types of fish smoked in Ghana. According to Kagan (14), the first two types are preserved by this method predominantly in the Volta, Greater Accra, and the Central and Western Regions of Ghana. Two methods of fish smoking (hot-smoking and smoke-drying) are generally practiced in Ghana. Smoke-drying is the method most widely practiced. Hot-smoking is usually carried out in the big cities where there is a ready market because hot-smoked fish have a relatively short shelf-life and also cannot be shipped for distances due to their fragile structure.

Fish for smoking may or may not be scaled depending on the species. Apart from large species, the guts are usually not removed and the gills are left intact (20). The prepared fish are arranged in layers separated by sticks in the smoking ovens and smoked with material such as wood chips, sugarcane chaff, coconut husks, etc. A temperature of 50-100°C for periods ranging from 3 to 12 h is usually used in hot-smoking. Approximately 20-40% moisture loss occurs in hot-smoking. Smoke-drying is done at relatively low temperatures for several hours, resulting in a drier product (22). This type of smoked fish is the form in which fish is mostly transported from the coast to remote areas. Smoke-dried fish has a moisture content of 10-15% and has better keeping qualities than the hot-smoked fish. However, if not appropriately stored and protected, over 50% may be lost through spoilage (29).

Salting and drying of fish ranks second to smoking in Ghana (19). The most popular varieties of salted-dried fish are trigger (*Balistes* sp.) and tilapia (cichlids, St. Peter's fish), mainly processed along the coastal region. Fish are prepared for salting and drying by gutting, scaling (in the case of tilapia), and washing. The salting is done by placing crude solar salt in the gut cavity and outside of the fish. The fish are arranged in wooden barrels or concrete tubs, with more salt sprinkled on each layer of fish. The ratio of salt to fish has been estimated to be in the range of 1:3 to 1:6 (20). The salted fish are covered and left for 1-3 days. After salting the fish are removed and spread out to dry in the sun. The salt/brine mixture formed after salting is usually reused 1-3 times with more salt addition. Drying lasts for 3-5 days.

Spanish mackerel (*Scomber japonicus*), cassava fish (*Cynoscion senegalla*), and seabream (*Lethrinus atlanticus*) are common examples of fermented fish. In the Greater Accra region, the fish are scaled, gutted, washed, and salted. The

salting is done either immediately or after the prepared fish has been left to stand for 19-48 h. The salted fish is fermented for a period ranging between 19 h to 6 days, after which they are sun-dried. Fermented fish (stink fish) is used mainly for flavoring soups and stews.

## EFFECT OF TRADITIONAL FOOD PRESERVATION TECHNIQUES ON NUTRIENT QUALITY

### Materials and Methods

In a preliminary study, the authors determined the nutrient composition of selected raw and processed Ghanaian foodstuffs in order to assess the effects of traditional preservation and storage techniques on the nutrient quality of these foods. Composite samples were made for each foodstuff and then replicated four times. Properties examined were proximate composition and some vitamins and minerals. The results are presented in Tables 1 to 3 as the means ("as-is" basis) of several market samples collected from the coastal savanna and inland forest regions of the country. Composition for each product was based on the edible portion. For fish samples, the scales or skin (in case of trigger fish), guts, gills, cover, fins, and central bones were discarded as wastes. To obtain the edible portion of raw cassava, the peels, head, and central fibrous core were removed.

**Table 1.** Nutritional Quality of Raw and Smoked Herrings

		Raw	Smoked
Moisture	(%)	71.5	11.3
Protein	(%)	23.2	66.4
Fat	(%)	3.9	15.4
Ash	(%)	2.3	6.8
Calcium	(mg/100 g)	373.6	1075.8
Phosphorus	(mg/100 g)	349.5	1706.2
Zinc	(mg/100 g)	1.6	4.8
Iron	(mg/100 g)	4.0	38.8
Riboflavin	(mg/100 g)	0.13	0.75
Thiamine	(mg/100 g)	0.01	0.06
Niacin	(mg/100 g)	0.09	0.60
Energy	(calories)	134	422

*Note:* Value are given on "as-is" basis for composite samples replicated four times.

**Table 2.** Effect of Preservation (salting and drying) on the Nutritional Quality of Trigger Fish (*Balistes* sp.) and Tilapia (St. Peter's fish)

Nutrient		Trigger fish		Tilapia fish	
		Raw	Salted, dried	Raw	Salted, dried
Moisture	(%)	75.5	36.6	74.0	27.3
Protein	(%)	16.3	42.9	17.1	31.3
Fat	(%)	2.1	3.9	6.3	15.1
Ash	(%)	5.5	19.5	2.9	26.2
Calcium	(mg/100 g)	429.1	1182.7	289.9	1700.5
Phosphorus	(mg/100 g)	403.9	983.3	672.5	872.8
Zinc	(mg/100 g)	1.7	6.5	0.8	3.0
Iron	(mg/100 g)	3.5	7.5	4.1	15.4
Energy	(calories)	88.0	218.0	130.0	270.0

*Note:* Values are given on "as-is" basis for composite samples replicated four times.

The apparent increases in the proximate and mineral composition of smoked fish samples (Table 1) can be explained in terms of the relatively low moisture content of the products. The processing methods used were not expected to cause any changes in these nutrients. However, appreciable increases were observed in the vitamin content of the product after smoking. As much as 100% increases occurred in the riboflavin, thiamin, and niacin content (compared to a dry weight basis). In his review of nutritional changes in fish through handling and processing procedures, Tarr (27) observed that processes such as smoking have no appreciable effect on the thiamin, riboflavin, and niacin concentrations. The differences observed here may have to be confirmed with different species of fish since handling could have accounted for changes in the fish, resulting in the increases. On the whole, apart from the beneficial preservation effect of smoking, the significant reduction in the moisture content results in a highly nutrient-dense product. The effect on the availability of essential nutrients may, however, have to be determined in further studies.

The effect of salt preservation on the nutritional quality of fish is presented in Table 2. For both trigger fish and tilapia, there were decreases in the fat content per dry matter unit after salting and drying. This may be due to physical losses facilitated by the breakdown of tissue cells during salting, followed by the heating effect of sun-drying. Although there was no significant change in the protein content of trigger fish after processing, an appreciable loss (on dry weight basis) occurred in processed tilapia. It is known that salting or procedures which involve salting are usually accompanied by protein losses (27). The significant



**Table 3.** Nutritional Quality of Raw Cassava (*Manihot excelsenta*) and Cassava Products (gari and kokonte)

Nutrient		Raw cassava	Cassava products	
			Gari	Kokonte
Moisture	(%)	58.0	8.5	9.7
Protein	(%)	1.0	1.9	1.4
Fat	(%)	0.4	0.3	0.6
Ash	(%)	1.0	0.8	1.0
Carbohydrates (by differences)	(%)	39.6	88.5	87.3
Calcium	(mg/100 g)	30.10	12.10	10.60
Phosphorus	(mg/100 g)	49.00	60.10	100.52
Zinc	(mg/100 g)	0.33	0.21	0.18
Iron	(mg/100 g)	2.60	3.60	3.50
Riboflavin	(mg/100 g)	0.03	0.01	0.01
Thiamine	(mg/100 g)	0.03	0.03	0.04
Niacin	(mg/100 g)	0.13	0.18	0.23
Energy	(calories)	166.00	350.00	346.00

*Note:* Values are given on "as-is" basis for composite samples replicated four times.

increases in ash content per unit of dry matter after salting and drying were due to the crude solar salt, which added more ash components to the product. The low moisture content of the processed products increased the protein and fat concentrations to over three times their original values. Based on unit weight of sample, therefore, more nutrients can be derived from the processed fish than the unprocessed.

Values obtained for the nutritional quality of cassava and its processed products (Table 3) were similar to those reported by other workers (9, 25). Nutritionally, cassava contributes mainly to the carbohydrate requirement of consumers. Processing cassava into gari or kokonte does not change this role as a source of calories in the Ghanaian diet. One advantage in the processing of cassava into gari is the detoxifying effect through hydrolysis of the cyanogenic glucosides (5).

## LOCAL RESEARCH IN TRADITIONAL FOOD PRESERVATION

Because of the significant role that traditional food preservation plays in the storage and supply of food in Ghana, local research institutions are actively involved

in studying and upgrading these techniques to improve efficiency and safety. The two major institutions concerned with traditional food preservation research in Ghana are the Food Research Institute (FRI) of the Council for Scientific and Industrial Research, and the Nutrition and Food Science Department of the University of Ghana. New techniques, or modifications of existing techniques, developed by these institutions are introduced to traditional processors through Extension and Demonstration. Processes have also been developed for intermediate products such as convenient, fortified, and shelf-stable foods prepared from various local raw materials for use in traditional food preparations. Some of these have been mentioned in various reports and publications (7, 16, 17, 23, 24). Such processes developed from the research findings are due for industrial adaptation.

In the area of root-crop processing and preservation, instant fufu powders are being developed from various root crops and tubers. "Fufu" is a popular Ghanaian food prepared by pounding boiled cassava and other starchy roots or tubers and plaintain into a smooth, semisolid meal. It is one of the most common end uses of fresh cassava and other root crops or tubers. The development of a shelf-stable fufu powder is, therefore, a major step in overcoming the problem of fresh root-crop preservation for the purpose of fufu preparation.

Although preservation of fruits and vegetables at the local level is not very popular, the Food Research Institute has over the years developed simple home canning and drying techniques for preserving those foodstuffs which have a high degree of postharvest losses each year. Successful preservation by solar drying has been conducted with garden eggs (eggplant), okra, pepper, and spinach (8). Additionally, garden eggs have been canned whole, or sliced and dehydrated (7). These products have been shown to retain most of their nutritive value. Studies have been carried out on the preservation of local fruits through the manufacture of jams, marmalades, fruit juices, and wines (2).

With traditional fish preservation, the Food Research Institute has developed an improved fish-smoking oven that is several times more efficient, in terms of fuel and product quality, than the traditional ovens (13). This has been widely adopted by traditional processors through Extension and Demonstration. Also in fish salting and drying, the FRI has introduced more efficient techniques that would improve quality and reduce production cost (19).

## CONCLUSION

Effective traditional techniques have been developed for the preservation of many locally produced foods in Ghana. techniques for the preservation of fish and root crops are very common, while fruits and vegetables are the least preserved food crops. Dehydration, smoking, salting, and fermentation are the most common processes used either singly or in combination for traditional food preservation. The products from these processes are almost always low in moisture

content, thus resulting in higher nutrient concentration than in the original material.

Local research institutions in the country have been carrying out studies on all aspects of traditional food processing and preservation, and upgrading the techniques for efficiency and safety. Some of the techniques developed from the research findings are modifications of existing traditional processes while others are new processing methods meant for industrial adaptation.

However, few data are available on the effects of unit operations used in traditional food preservation techniques on biological availability of essential nutrients. Effects of storage conditions on the stability of the preserved foods have also not been exhaustively explored. More research efforts are needed in this direction.

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